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# FLOOD INSURANCE STUDY

ORIGINAL

## VILLAGE OF WARWICK, NEW YORK
## ORANGE COUNTY

MARCH 4, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 360637

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map



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FLOOD INSURANCE STUDY
VILLAGE OF WARWICK, NEW YORK

# 1.0 INTRODUCTION

## 1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Village of Warwick, Orange County, New York, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

## 1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by Leonard Jackson Associates for the Federal Emergency Management Agency (FEMA), under Contract No. EMW-R-0690. This work was completed in December 1984.

## 1.3 Coordination

In April 1983, streams to be studied by detailed methods were identified at an initial Consultation and Coordination Officer's (CCO) meeting attended by representatives of FEMA, the Village of Warwick, and Leonard Jackson Associates (the study contractor). During the course of the study, village officials and residents were contacted to obtain pertinent flood information. On April 26, 1985, the results of the study were reviewed at a final CCO meeting held with representatives of FEMA, the village, and the study contractor.

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## 2.0 AREA STUDIED

### 2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Village of Warwick, Orange County, New York. The area of study is shown on the Vicinity Map (Figure 1).

Wawayanda Creek and South Tributary to Wawayanda Creek were studied by detailed methods for their entire lengths within the corporate limits. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction through December 1989.

An unnamed tributary to South Tributary to Wawayanda Creek was studied by approximate methods. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the Village of Warwick.

### 2.2 Community Description

The Village of Warwick is located in the southern portion of Orange County in southeastern New York, approximately 35 miles northwest of New York City. It is completely surrounded by the Town of Warwick. The total land area contained within the village limits is approximately 2 square miles. The population of the village was estimated at 4,433 in 1984.

Wawayanda Creek originates at Wickham Lake and flows west to its confluence with Pochuck Creek. The drainage area of Wawayanda Creek at the western corporate limits of Warwick is approximately 30 square miles.

South Tributary to Wawayanda Creek originates in the Warwick Mountain Range and flows north to its confluence with Wawayanda Creek. The drainage area at its confluence is approximately 2.8 square miles.

The climate of Warwick is characterized by long summers and short winters. The average annual temperature is approximately 50 degrees Fahrenheit (°F), with extremes varying from -24°F to 106°F. The average annual precipitation is approximately 45 inches. The observed annual extremes were 68.31 inches at Greenwood Lake, New Jersey (1952), and 29.54 inches at Walden, New York (1941). The distribution of precipitation throughout the year is fairly uniform, with slightly higher amounts during the summer months.



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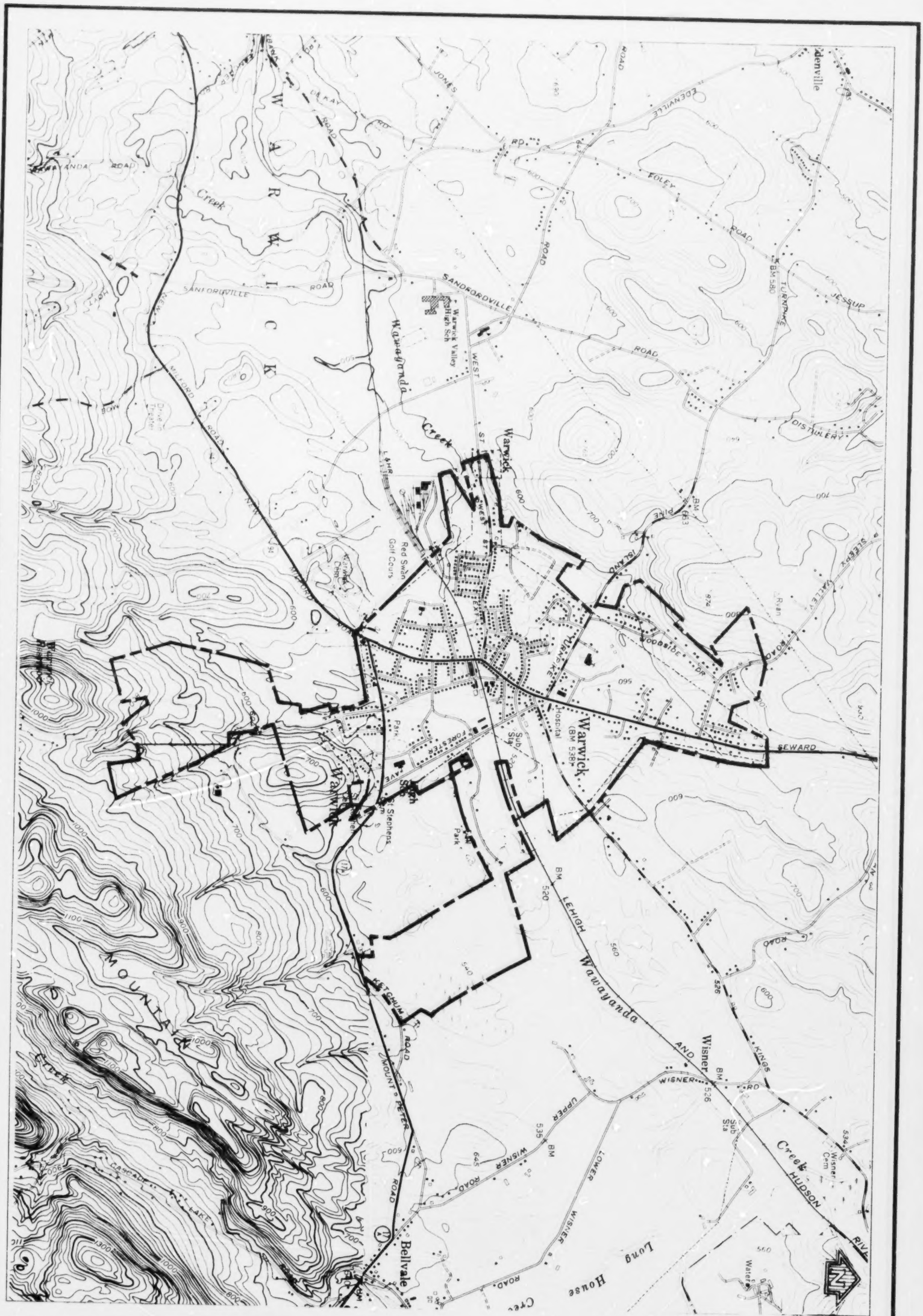


FEDERAL EMERGENCY MANAGEMENT AGENCY

**VILLAGE OF WARWICK, NY**
(ORANGE CO.)

APPROXIMATE SCALE
2000 0 2000 4000 6000 FEET

**VICINITY MAP**

**FIGURE 1**



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## 2.3 Principal Flood Problems

Major floods have occurred in the study area during all seasons, but generally the most notable floods have occurred between June and November when the area is susceptible to heavy thunderstorms and the torrential rains associated with hurricanes that cause streams to rise rapidly. Snowmelt, combined with spring rains, also presents a threat of flooding in the area. The flood of record occurred on April 5-6, 1984, when heavy rains and snowmelt caused substantial damage to the municipal reservoir and flooded many basements.

## 2.4 Flood Protection Measures

A 2,000-foot portion of South Tributary to Wawayanda Creek was improved by straightening and clearing the channel to increase its conveyance. Storm sewers were constructed to convey local runoff. Several dams are located on the streams within the surrounding Town of Warwick; however, none of these dams has an effect on flood flows.

Non-structural measures of flood protection are being utilized to aid in the prevention of future flood damage. These measures are in the form of land-use regulations which control building within areas that have a high risk of flooding.

# 3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.



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## 3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Peak discharges for Wawayanda Creek were obtained from the Flood Insurance Study for the Town of Warwick (Reference 1). The hydrologic analysis for South Tributary to Wawayanda Creek was computed using the Soil Conservation Service (SCS) Technical Release 55 (Reference 2). This is a statistical method that develops peak discharges for selected recurrence intervals based on the parameters of basin size, average channel slope, basin ponding areas, and runoff curve number.

A summary of drainage area-peak discharge relationships for Wawayanda Creek and South Tributary to Wawayanda Creek is shown in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

| FLOODING SOURCE AND LOCATION | DRAINAGE AREA (sq. miles) | PEAK DISCHARGES (cfs) 10-YEAR | 50-YEAR | 100-YEAR | 500-YEAR |
|---|---|---|---|---|---|
| WAWAYANDA CREEK | | | | | |
| At the downstream corporate limits | 30.0 | 830 | 1,400 | 1,700 | 2,600 |
| Upstream of Seward Highway Tributary | 24.4 | 590 | 990 | 1,200 | 1,900 |
| SOUTH TRIBUTARY TO WAWAYANDA CREEK | | | | | |
| At its confluence with Wawayanda Creek | 2.83 | 740 | 820 | 970 | 1,280 |

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections for the backwater analyses were obtained from aerial photographs (Reference 3). The below-water sections were obtained by field measurement. All bridges and culverts were field surveyed to obtain elevation data and structural geometry.



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Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (Reference 4). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Starting water-surface elevations for Wawayanda Creek were obtained from the Flood Insurance Study for the Town of Warwick (Reference 1). Starting water-surface elevations for South Tributary to Wawayanda Creek were determined by the slope/area method.

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on field observations of the streams and flood plain areas. For the streams studied by detailed methods, the channel "n" values ranged from 0.030 to 0.040, and the overbank "n" values ranged from 0.050 to 0.120. An "n" value of 0.015 was used for concrete structures, and 0.024 was used for corregated metal pipes. A weighted average "n" value was used for bridges with steel decks, concrete abutments, and earthen bottoms. Non-effective flow areas were disregarded by using extremely high "n" values. The acceptability of all assumed hydraulic factors, cross sections, and hydraulic structure data was checked by computations that duplicated historic flood profiles.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

## 4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

### 4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual



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chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (Reference 5).

For the stream studied by approximate methods, the boundary of the 100-year flood was delineated using the Flood Hazard Boundary Map for the Village of Warwick (Reference 6).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

## 4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.



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| FLOODING SOURCE | | FLOODWAY | | | BASE FLOOD WATER SURFACE ELEVATION | | | |
|---|---|---|---|---|---|---|---|---|
| CROSS SECTION | DISTANCE | WIDTH (FEET) | SECTION AREA (SQUARE FEET) | MEAN VELOCITY (FEET PER SECOND) | REGULATORY | WITHOUT FLOODWAY | WITH FLOODWAY | INCREASE |
| | | | | | (FEET NGVD) | | | |
| Wawayanda Creek | | | | | | | | |
| A | 700[1] | 332 | 1,428 | 1.2 | 508.8 | 508.8 | 509.6 | 0.8 |
| B | 1,870[1] | 124 | 443 | 3.8 | 509.4 | 509.4 | 510.4 | 1.0 |
| C | 3,300[1] | 66 | 509 | 3.3 | 514.1 | 514.1 | 514.6 | 0.5 |
| D | 4,340[1] | 78 | 512 | 3.3 | 515.8 | 515.8 | 516.6 | 0.8 |
| E | 5,967[1] | 224 | 898 | 1.9 | 519.9 | 519.9 | 520.8 | 0.9 |
| F | 7,047[1] | 289 | 2,272 | 0.5 | 520.2 | 520.2 | 521.1 | 0.9 |
| G | 7,547[1] | 280 | 2,230 | 0.5 | 520.3 | 520.3 | 521.2 | 0.9 |
| H | 8,957[1] | 270 | 1,973 | 0.6 | 520.3 | 520.3 | 521.2 | 0.9 |
| South Tributary to Wawayanda Creek | | | | | | | | |
| A | 750[2] | 114 | 334 | 2.9 | 521.2 | 521.2 | 522.0 | 0.8 |
| B | 1,440[2] | 138 | 536 | 1.8 | 525.2 | 525.2 | 526.2 | 1.0 |
| C | 2,000[2] | 70 | 143 | 6.8 | 527.7 | 527.7 | 528.3 | 0.6 |
| D | 2,600[2] | 42 | 115 | 8.4 | 533.1 | 533.1 | 533.1 | 0.0 |
| E | 3,020[2] | 45 | 210 | 4.6 | 537.3 | 537.3 | 538.1 | 0.8 |

[1]Feet from corporate limits

[2]Feet above confluence with Wawayanda Creek

TABLE 2

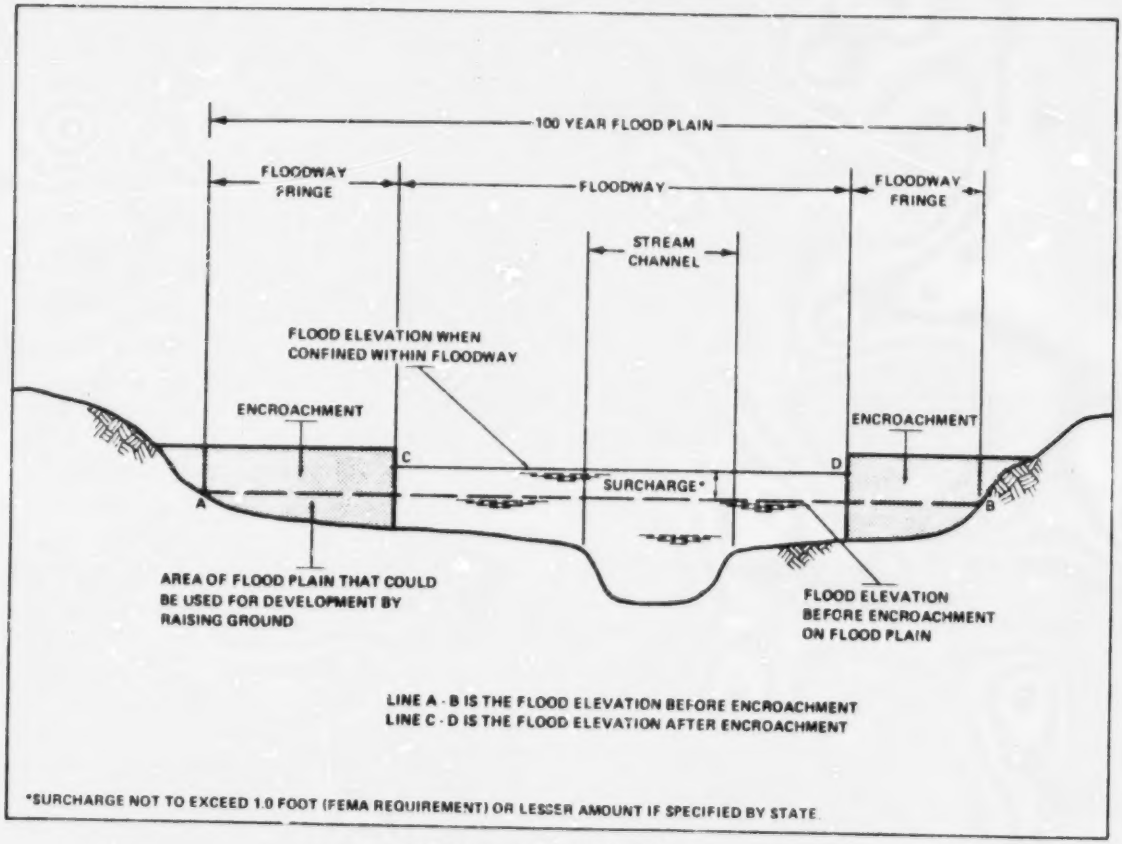
FEDERAL EMERGENCY MANAGEMENT AGENCY

**VILLAGE OF WARWICK, NY**
(ORANGE CO.)

**FLOODWAY DATA**

**WAWAYANDA CREEK –
SOUTH TRIBUTARY TO WAWAYANDA CREEK**

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FLOODWAY SCHEMATIC Figure 2

## 5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the Village of Warwick.



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## 5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

| Average Difference Between 10- and 100-Year Floods | Variation |
|---|---|
| Less than 2 feet | 0.5 foot |
| 2 to 7 feet | 1.0 foot |
| 7.1 to 12 feet | 2.0 feet |
| More than 12 feet | 3.0 feet |

The locations of the reaches determined for the flooding sources of the Village of Warwick are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

## 5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

## 5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.



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| FLOODING SOURCE | PANEL[1] | ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND | | | FHF | ZONE | BASE FLOOD ELEVATION[3] (NGVD) |
|---|---|---|---|---|---|---|---|
| | | 10% (10 YR.) | 2% (50 YR.) | 0.2% (500 YR.) | | | |
| Wawayanda Creek | | | | | | | |
| Reach 1 | 01 | -2.1 | -0.6 | +1.6 | 020 | A4 | Varies |
| Reach 2 | 01 | -3.0 | -1.0 | +1.9 | 030 | A6 | Varies |
| South Tributary to Wawayanda Creek | | | | | | | |
| Reach 1 | 01 | -0.8 | -0.2 | +0.5 | 010 | A2 | Varies |

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

**VILLAGE OF WARWICK, NY**
(ORANGE CO.)

**FLOOD INSURANCE ZONE DATA**

**WAWAYANDA CREEK –
SOUTH TRIBUTARY TO WAWAYANDA CREEK**



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| | |
|---|---|
| Zones A2, A4, and A6: | Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs. |
| Zone B: | Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided. |
| Zone C: | Areas of minimal flooding; not subdivided. |

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 3.

### 5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Village of Warwick is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

## 6.0 OTHER STUDIES

The Flood Insurance Study for the Town of Warwick is currently being prepared (Reference 1). The results of that study will be in exact agreement with the results of this study.

## 7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, Regional Director, Region II Office, 26 Federal Plaza, Room 19-100, New York, New York 10278.



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## 8.0 BIBLIOGRAPHY AND REFERENCES


1. Federal Emergency Management Agency, Flood Insurance Study, Town of Warwick, Orange County, New York (Unpublished).

2. U. S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, Urban Hydrology for Small Watersheds, Washington, D. C., January 1975.

3. Geomaps, Inc., of Mineola, New York, Aerial Photographs, Scale 1:9,600: Village of Warwick, Orange County, New York, flown in November 1981.

4. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, October 1973.

5. Geomaps, Inc., of Mineola, New York, Topographic Maps compiled from aerial photographs, Scale 1:4,800, Contour Interval 4 Feet: Village of Warwick, Orange County, New York, December 1981.

6. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Village of Warwick, Orange County, New York, January 30, 1976.

U. S. Department of Commerce, Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of the United States, Washington, D. C., 1961, Revised 1963.

U. S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 10 Feet: Greenwood Lake, New York, 1942, Photorevised 1954; Warwick, New York, 1943, Photorevised 1957.




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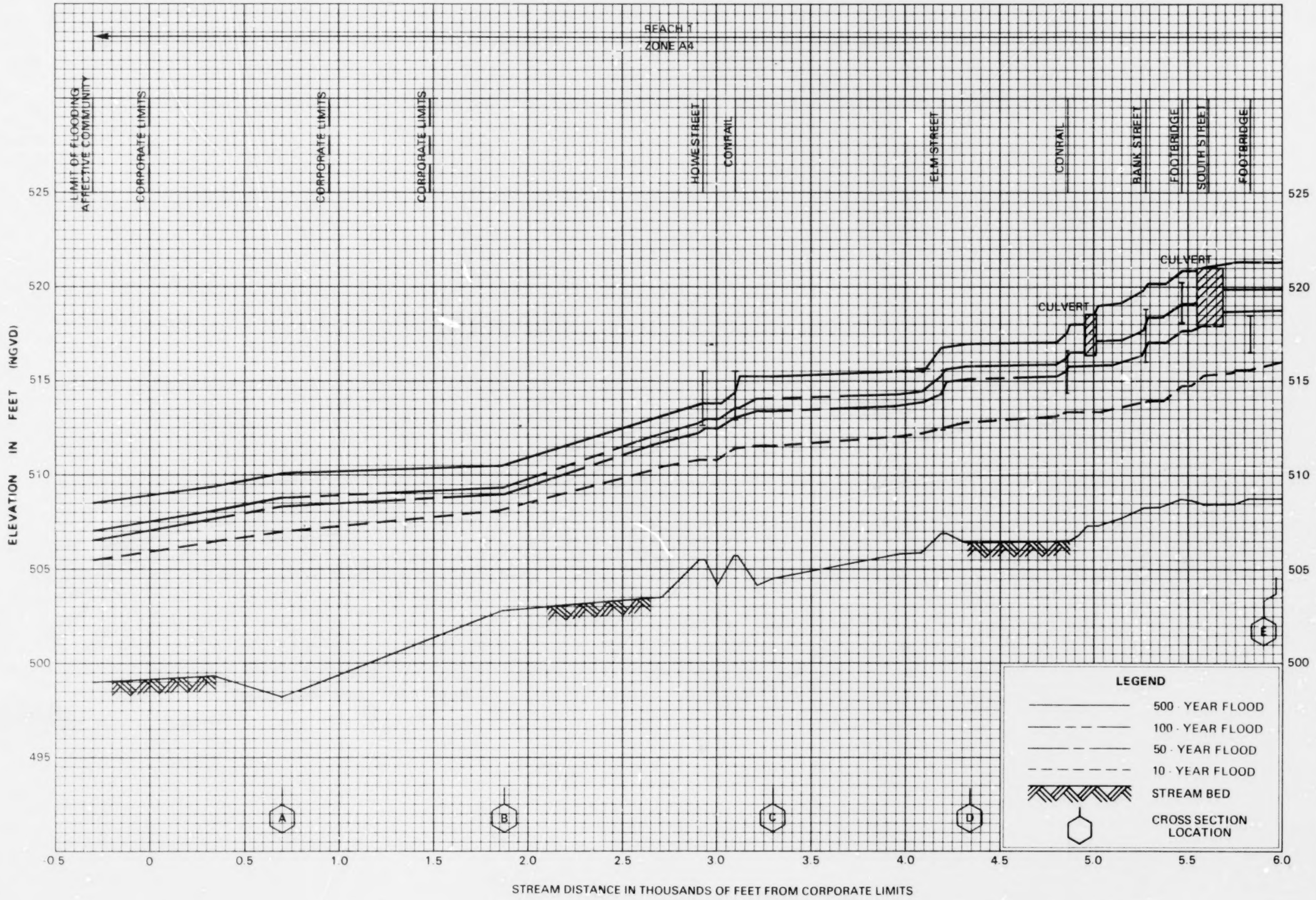


**FLOOD PROFILES**

**WAWAYANDA CREEK**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**VILLAGE OF WARWICK, NY**

**(ORANGE CO.)**

**01P**



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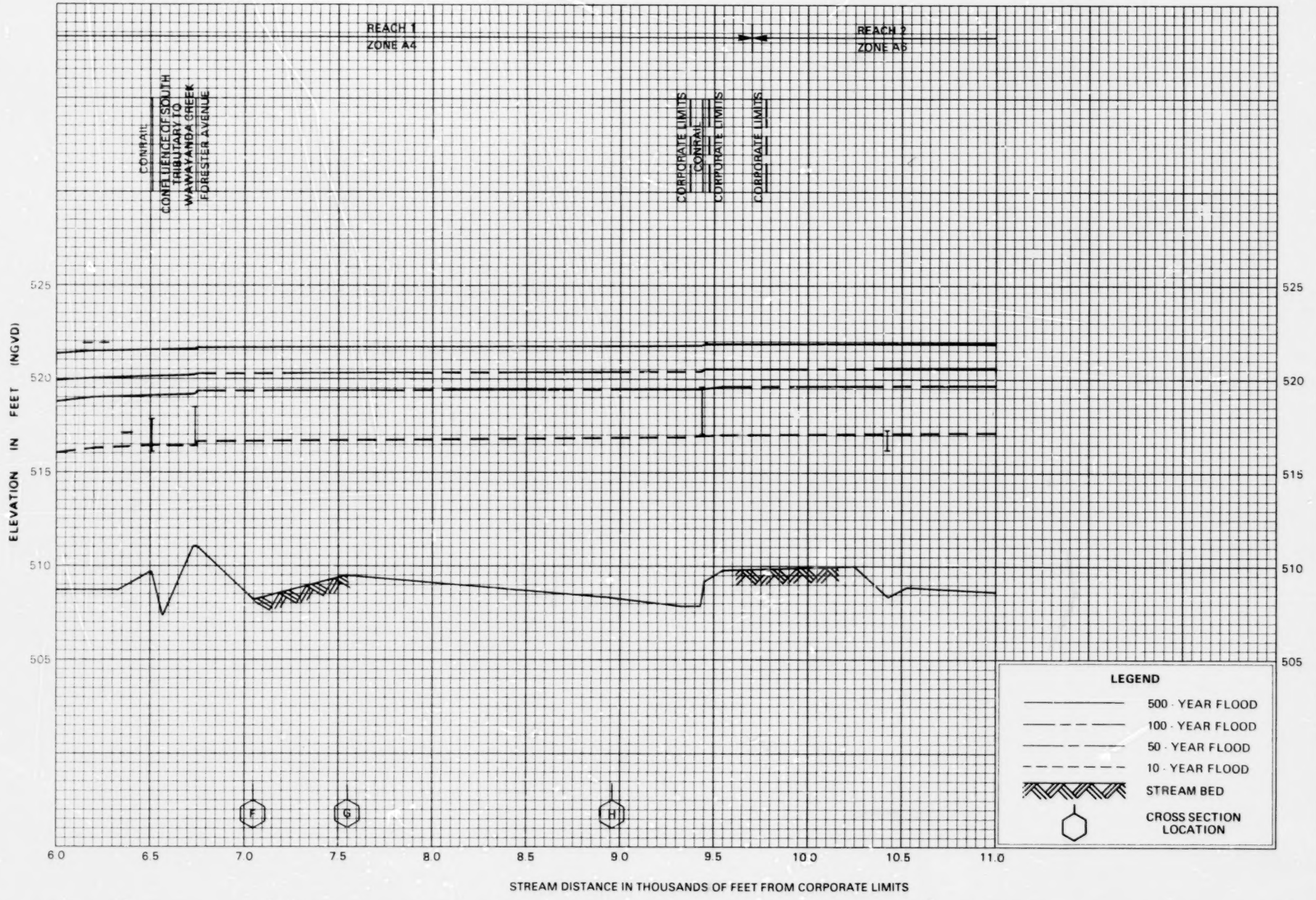


FLOOD PROFILES

WAWAYANDA CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

VILLAGE OF WARWICK, NY
(ORANGE CO.)

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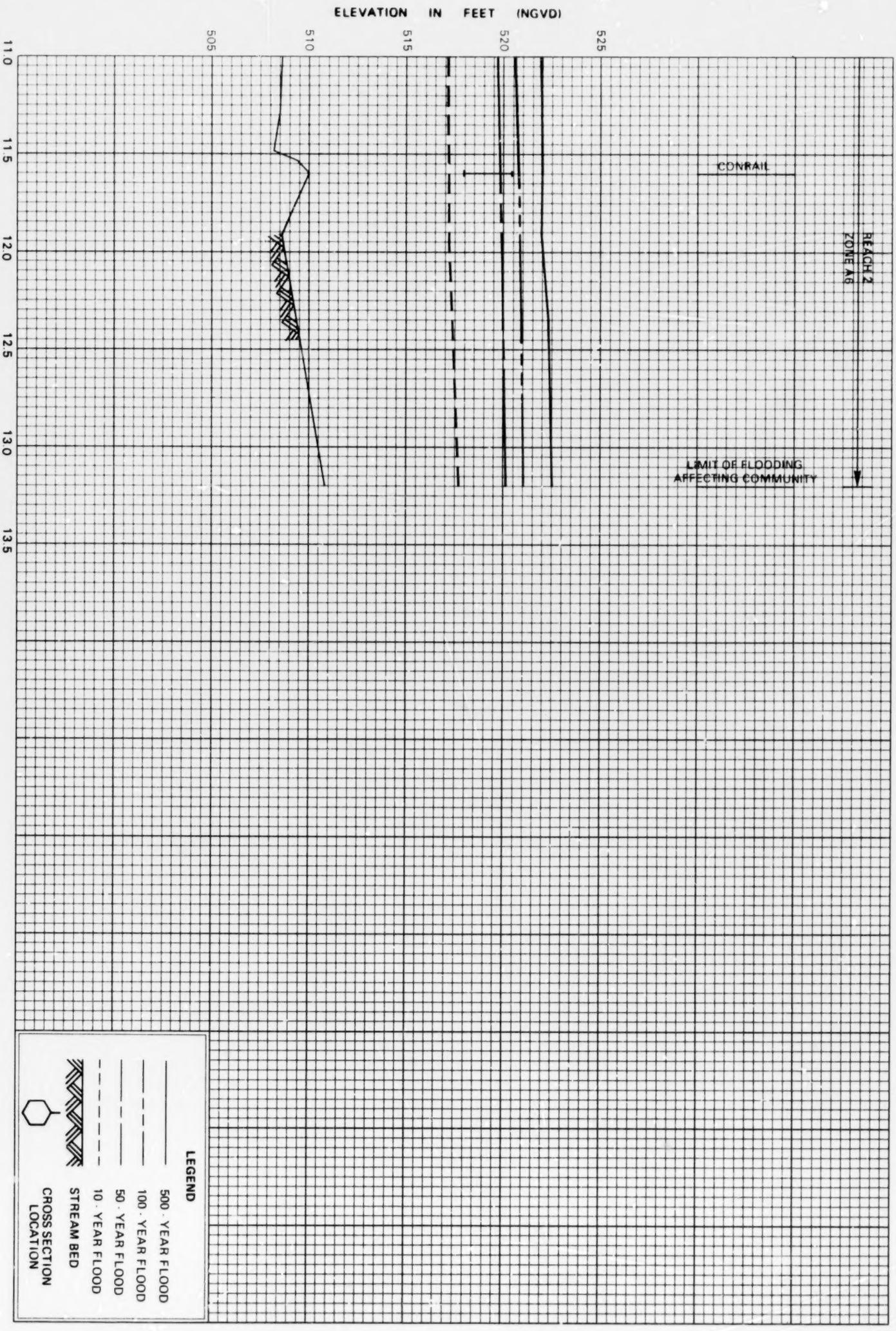


STREAM DISTANCE IN THOUSANDS OF FEET FROM CORPORATE LIMITS

16

| 03P | FEDERAL EMERGENCY MANAGEMENT AGENCY<br>**VILLAGE OF WARWICK, NY**<br>(ORANGE CO.) | **FLOOD PROFILES**<br>**WAWAYANDA CREEK** |
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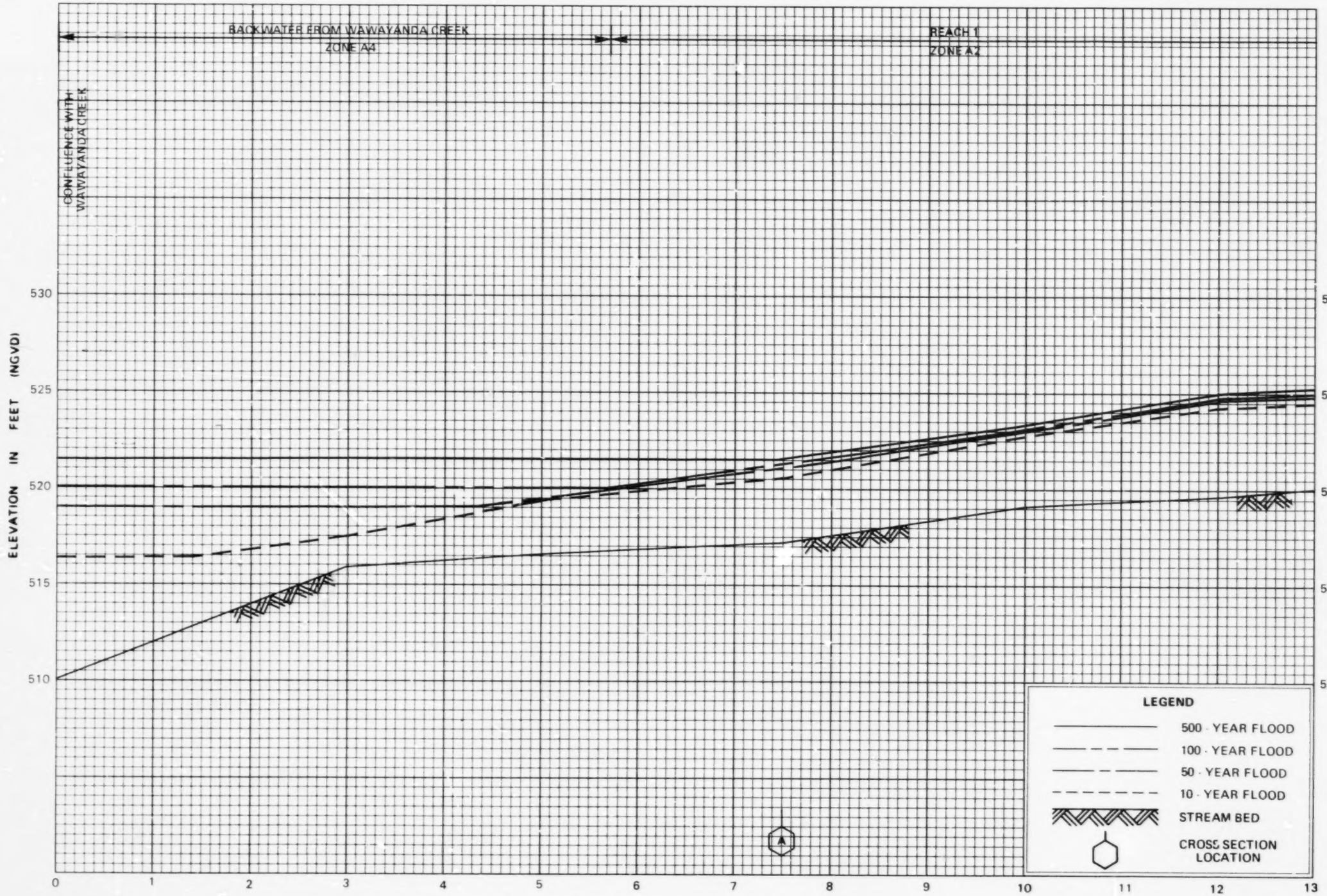


**FLOOD PROFILES**

**SOUTH TRIBUTARY TO WAWAYANDA CREEK**

FEDERAL EMERGENCY MANAGEMENT AGENCY

**VILLAGE OF WARWICK, NY**

(ORANGE CO.)

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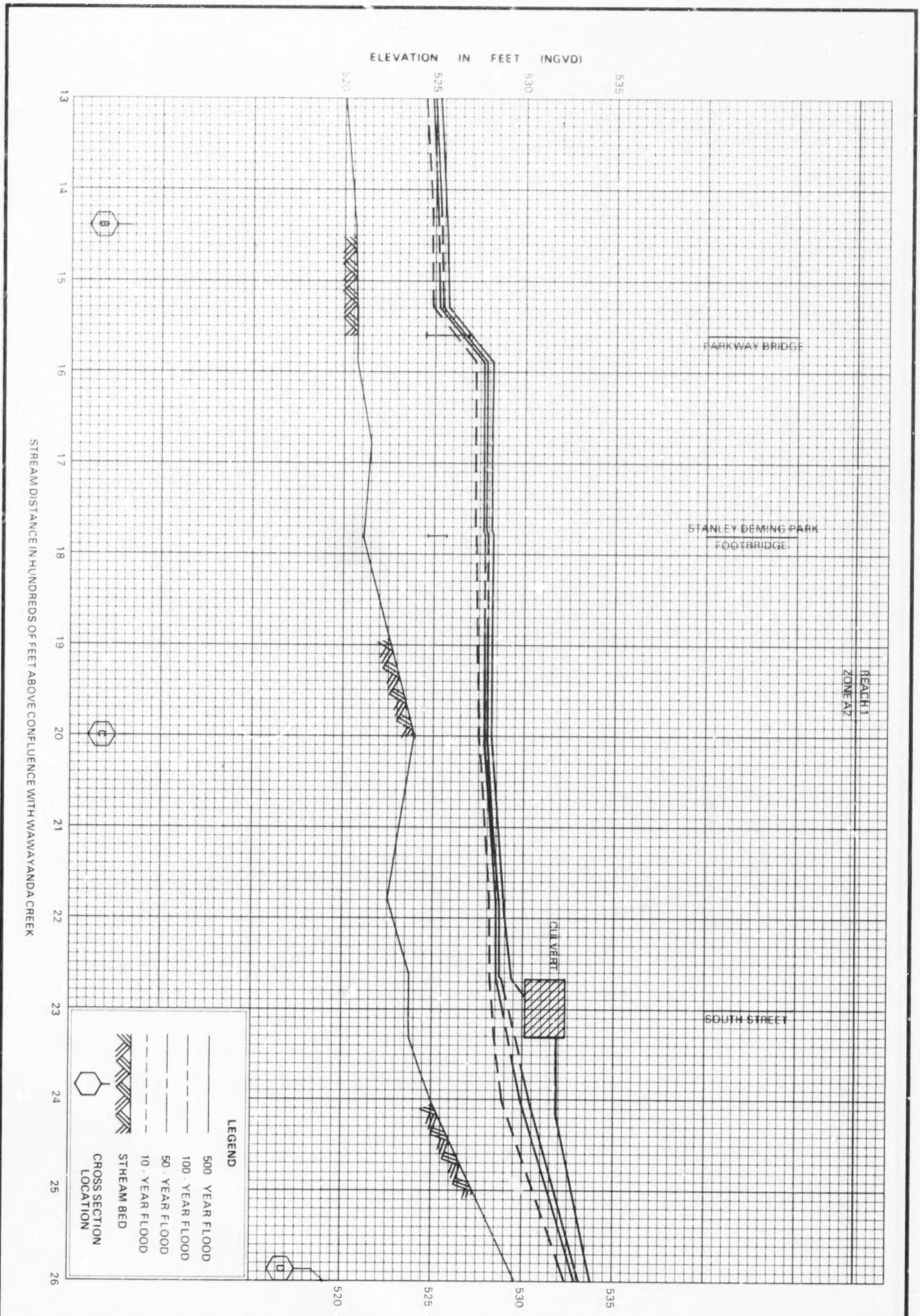


FEDERAL EMERGENCY MANAGEMENT AGENCY

**VILLAGE OF WARWICK, NY**

(ORANGE CO.)

**FLOOD PROFILES**

**SOUTH TRIBUTARY TO WAWAYANDA CREEK**

05P

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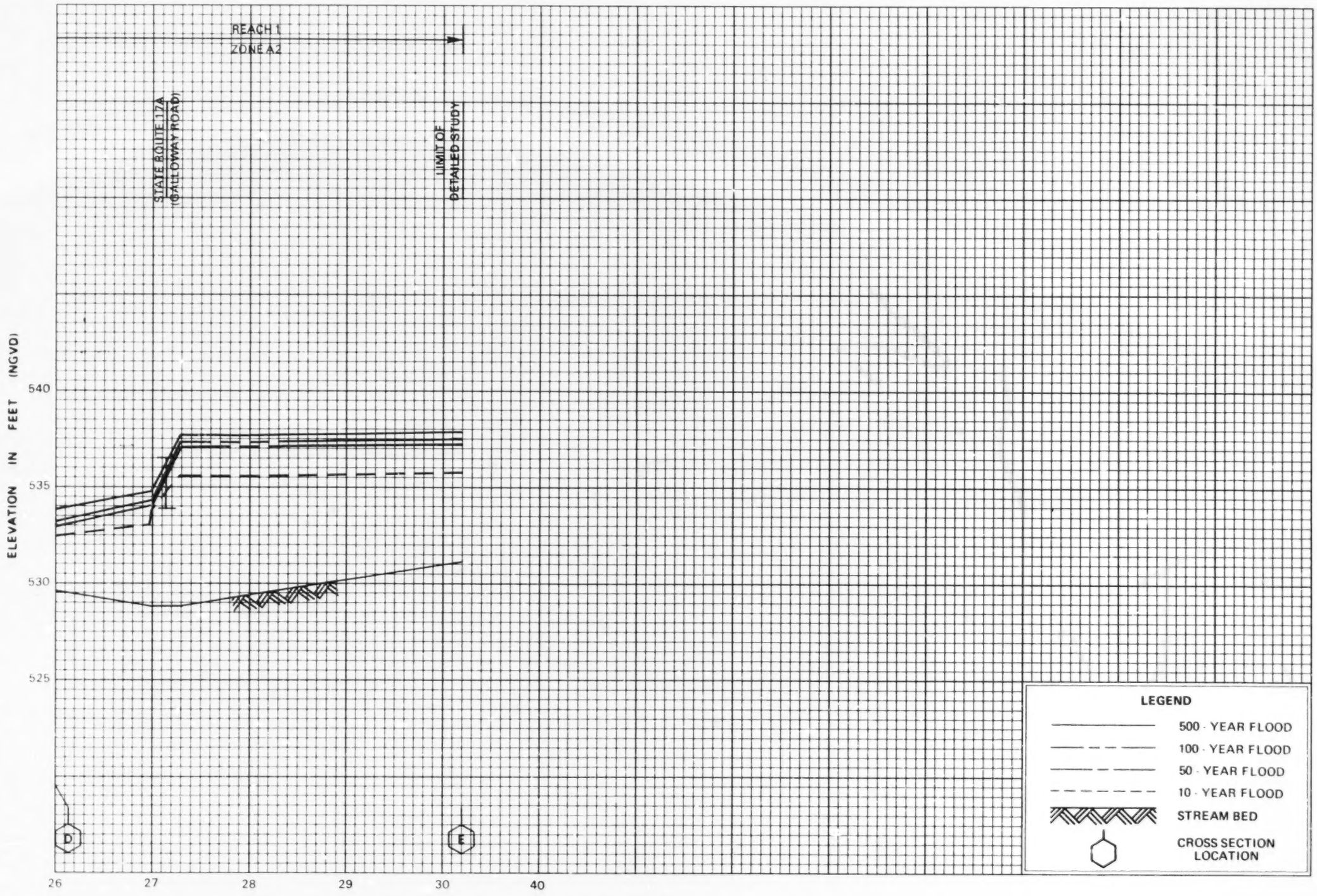


FLOOD PROFILES

SOUTH TRIBUTARY TO WAWAYANDA CREEK

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